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Efficiency of Indigenous AMF Species on Growth of Soybean (*Glycine max* L.) under Varying Levels of Phosphorous in Saline Condition

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Abstract: ***The pot experiments were undertaken to study the relative efficiency of dominant AM Fungi (Glomus fasciculatum and Glomus heterosporum) recovered from natural undisturbed saline belt of Purna river sub basin. The pure inoculum of these species were treated individually and as a mixed inocula in combination with phosphoric fertilizers supplied as 25, 50, 75 and 100% (mg/kg P_2O_5 /ha). The influence of AMF inoculation in different levels of 'P' fertilizer on% colonization, MIE % and P-uptake were calculated. P-level of 75% was found to be better in compare to 100% and can be recommended as phosphoric dose for soybean plants.***

Keywords: AMF, *Glycine max*, P-uptake, soil salinity

1. Introduction

AM (Arbuscular Mycorrhizal) Fungi, are found to be associated with a number of leguminous crop plants (Bagyaraj et al., 1979; Tilak et al., 1987; Vijay kumar and Bhiravamurthy, 1999) and beneficial effects of these fungi in phosphate uptake have been reported by different workers (Islam and Ayaneba, 1980; Reinhard et al., 1994 and Rajeshwari et al., 2001).Most of the work has been focused on phosphate nutrition, because 'P' is one of the major plant nutrients. Soybean being a legume, helps in improving the soil fertility, the relative efficiency of different AM isolates on soybean under varying levels of 'P' has been reported by Raverkar and Tilak (1988); Kabirun and Widada (1994) and established that effect of AM fungal inoculation on soybean depends on the AM species as well as on the soil where the soybean is grown. Phosphorus is one of the most least available macronutrient in the soil of Vidarbha region and its unavailability is one of the major growth limiting factors for plants in many natural and artificial ecosystems. The present study elucidated the relative influence of indigenous AM fungi and different phosphoric fertilizer doses on soybean under saline conditions of soil. In response to continual 'P' deficiency, plants bound to adopt many mechanisms for 'P' uptake and sustainability (Singh and Jamaluddin, 2008).

2. Materials and Methods

The dominant AMF spores of *Glomus* species (*Glomus fasciculatum* (Thaxter) Gerdemann &Trappe emend. Walker and Koske *and Glomus heterosporum* Smith & Schenck) were isolated from the rhizosphere soils of natural ecosystem of Purna river saline tract of Amravati District. The isolation of AM spores was carried out by the wet-siewing and decanting technique (Gerdemann and Nicolson, 1963) and the isolated spores were identified on the basis of their morphological characters given in the identification manual of AM fungi (Schenk and Perez, 1990) and key of Mortan and Benny (1990).AMF spores of the most dominant species were purified and multiplied by following funnel technique (Mertz et al.,1979). The pure culture of isolated AM fungi was used for inoculation for *Glycine max.*

3. Experimental Set Up

A pot experiment was set up with sterilized saline clayey loam soil brought from village Nanded (Khurd) located in saline belt of Purna river sub basin. The experimental soil used were having pH 8.2, Ec_2 0.28dsm^{-1}, electrical conductivity 1.69 dsm^{-1}, nitrogen (84.2 kg/ha),phosphorus (6.7 kg/ha)potassium (441 kg/ha) Org. carbon 0.219 %. The isolated pure inoculums of *Glomus fasciculatum and Glomus heterosporum* along with root bits of maize plants were mixed equally in pot soils (1:1 soil+ sand) as 60g of inoculums individually and in mixed combinations. The soil was also supplemented with single super phosphate dose of P_2O_5 in different quantities as 25, 50, 75 and100%. The phosphoric fertilizer doses were calculated as per the standard recommended dose per hector for soybean.

The sterilized five seeds of soybean were sown in each pot and irrigated with deionized sterilized water regularly. Percent root colonization, MIE %, spore count/100g of soil and P-uptake of soybean was recorded after every 15, 30 and 45 days of sowing. The grid-line intersect method was adopted for % root colonization (Giovannetti and Mosse, 1980). The mycorrhizal inoculation effect (MIE) on test crop plant was calculated by the formula given by Bagyaraj et al.(1988) for growth improvement brought about by mycorrhizal inoculation. The total P-uptake by uninoculated and inoculated plants were calculated after experiment by Vando molybdate phosphoric yellow colour method given by Jakson(1967).

4. Results and Discussion

Mycorrhizal plants produced higher root colonization at all levels of phosphate than uninoculated control plants. A wide variation was observed in the rate of the root colonization by two AM species at different levels of phosphate.

Percent Colonization. The microscopic examination of the root samples showed colonization in roots of soybean plants inoculated with mycorrhizal fungi. The plants inoculated with mixed inocula at P 75% level and LFSC (*Glomus fasciculatum*) at P 75% level exhibited highest % colonization in compare to other P-levels while the % colonization was found to be inhibited at higher levels of phosphorus (Table-1).Interaction effect between P levels and AM isolates differed significantly in influencing % colonization of root(Table 1A) Neither extra matrical hyphae nor spore was recovered from the non mycorrhizal control plants (because it was planted in sterile soil sand mixture without inoculum). The root colonization by two AMF species namely *Glomus fasciculatum* and *Glomus heterosporum* was inhibited at higher levels of phosphates similar observations were recorded by Raverkar and tilak (1988) with *G.fasciculatum* and *Acaulospora* sp.

MIE %. The results are presented in Table-1. There was linear increase in MIE % with successive increase in levels of phosphorus from 0 to 75%. Application of 75 % P_2O_5 recorded highest MIE % in *Glycine max* i.e. 55.40 % and 60.90% at 30 and 45 days after sowing respectively, which was significantly more than other P-levels. Interaction effects between phosphorus levels and AMF isolates on MIE % of *Glycine* max are presented in Table 2A.The results proved that mixed inocula of two AMF isolates gave more consistent results and found to be more beneficial. Similar type of observations have been recorded by Daft and Hogarth (1983) and Mehrotra and Baijal (1995).

P- uptake. Mycorrhizal association can enhance the uptake of 'P' was earlier reported by Plenchette et al.,1983 and Bolant,1991. The studies on the effect of P-uptake and plant growth were also carried out in different plant species by Prasad et al., 2000; Rajeshwari et al., 2001. In the present findings dual inocula recorded 8.90 mg/plant phosphorus, this was found significantly superior than other single AMF islolates at 45 days after sowing. Application of P_2O_5 at 75 % recorded highest 'P' uptake i.e. 9.36 mg/plant which were found significantly more than 100, 50 and 25 % P_2O_5. The interaction effect of 75 % P_2O_5 with dual inocula also recorded higher uptake of 'P' i.e.12.68 mg/plant which was significantly more than all other treatments (Table-2). Improved plant phosphorus uptake by AM inoculation in phosphorus deficient soil has been reported earlier by Marschner and Dell, 1994; Neeraj and Anju Chavan, 2006. Fathima et al.,2000 and Yao et al., 2001 and concluded that AMF species are responsible for more 'P' uptake than non-mycorrhizal plants. The present findings are in acquiescence with the conclusion made by earlier researchers. The highest level (100%) of 'P' proved to be inhibitory in P-uptake for *G.max*. The similar observations were earlier made by Krishna and Bagyaraj (1982) with 200% of 'P' and Raverkar and Tilak (1988) at 100kg P_2O_5/ha.

The possibility of inoculating *G.max* with native dominant isolates of AMF can tremendously improve the prospects of successfully exploiting AMF for better yield of legumes, especially those growing in a low input system where concentration of soil phosphate pool is likely to be lower. Hence, these AMF species can be utilized as a bio fertilizer and 25% of 'P' fertilizer can be saved in the fields of *G.max* in salinity affected regions.

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Table 1: Effect of different levels of phosphorus and AM isolate on % colonization and MIE % of *Glycine max*

Treatments	*% Colonization*			*MIE %*	
Main factor 'A'	15 DAS	30 DAS	45 DAS	30 DAS	45 DAS
P0	25.44	32.60	55.30	19.46	31.87
P25	29.00	41.27	55.67	33.60	47.30
P50	26.17	44.11	61.17	45.50	52.43
P75	36.67	52.33	71.43	55.40	60.90
P100	27.67	51.50	63.57	36.87	49.17
F' test	Sig	Sig	Sig	Sig	Sig
SE(M)	3.60	5.38	1.90	0.48	0.54
CD (P=0.05)	8.31	12.43	4.38	1.12	1.24
Sub factor 'B'					
M	37.07	47.50	62.40	55.40	62.86
LHTS	24.60	41.40	54.06	23.63	32.26
LFSC	25.30	44.19	67.82	35.46	49.88
F' test	Sig	Sig	Sig	Sig	Sig
SE(M)	2.56	3.77	1.70	0.27	0.33
CD (P=0.05)	5.36	7.88	3.55	0.57	0.68

(LHTS*Glomus heterosporum*, LFSC*Glomus fasciculatum*, MIE-Mycorrhizal Inoculation Effect)

Table 1-A: Interaction effect of different levels of phosphorus and AM isolates on % colonization, MIE % of *Glycine max*

	% Colonization									*MIE %*					
	15 DAS			*30 DAS*			*45 DAS*			*30DAS*			*45DAS*		
Treatment	M	LHTS	LFSC	M	LHTS	LFSC	M	LHTS	LFSC	LFSC	M	LHTS	LFSC	M	LHTS
P0	31.33	22.00	23.00	42.00	40.00	15.79	56.00	47.00	62.90	18.70	48.00	-8.33			
P25	35.00	23.00	29.00	45.00	36.00	42.80	57.00	53.00	57.00	27.00	55.10	18.70			
P50	40.00	25.00	13.51	45.00	38.00	49.33	60.00	52.50	71.00	48.00	53.50	35.00			
P75	46.00	29.00	35.00	53.00	47.00	57.00	72.00	62.80	79.50	56.60	63.80	45.80			
P100	33.00	24.00	26.00	52.00	46.00	56.00	67.00	55.00	68.70	27.00	56.60	27.00			
F' test	Sig			Sig			Sig			Sig					
SE(M)	1.48			2.18			0.98								
CD (P=0.05)	3.09			4.55			2.05								

Table 2: Interaction effect of different levels of phosphorus and AM isolates on P – uptake of *Glycine max*

Treatment	*M*	*LHTS*	*LFSC*
P0	6.56	2.62	4.46
P25	8.75	3.60	7.00
P50	9.45	5.25	8.05
P75	12.68	6.65	8.75
P100	7.08	4.46	4.46
F' test	Sig		
SE(M)	0.18		
CD (P=0.05)	0.39		